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ABSTRACT

This report reviews eight IBM-compatible software packages that are available to secondary schools to teach computer-aided drafting (CAD). Software packages to be considered were selected following reviews of CAD periodicals, computers in education periodicals, advertisements, and recommendations of teachers. The packages were then rated by teachers on criteria that included cost of software and hardware needed to run it, ease of use, ease of set-up, and the availability of coordinated curriculum materials. The following packages are reviewed in this report: AutoCAD; CADKey 1.4E/CADKey 3.0; CADLab; CADVance; Generic CADD 3.0; Junior Drafter 1.2; and VersaCAD DESIGN Version 5.2. Information is provided on publisher, price, working with the system, ease of use, and comprehensiveness. A chart comparing features of these packages and suggestions on choosing a CAD software package are provided. (KC)

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THE Northwest Regional Educational Laboratory

TECHNOLOGY PROGRAM

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COMPUTER AIDED DRAFTING PACKAGES FOR SECONDARY EDUCATION

EDITION 2

PC DOS Compatible Programs

A MicroSIFT Quarterly Report

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March 1988

by

Jim Pollard

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INTRODUCTION

The term CAD means "Computer Aided Drafting" (or sometimes "Computer Aided Design"). CAD is important in schools because it is important in the world outside of school. Virtually all design work in architecture, mechanical engineering, civil engineering and electrical engineering is done with a computer, with very little design currently done on the traditional drafting table. There are several reasons for the switch to CAD, among them are:

- Speed. An experienced user of a CAD system can produce a finished drawing in much less time than it would take an experienced drafter using manual tools.
- Ease of editing. Only the parts of a drawing which must be changed need to be redrawn in case of a change of plans or a new project which builds on an old one.
- Stored symbols. Much of drafting involves redrawing the same basic figures many times. In traditional drafting, specialized templates are available to make this redrawing easier. In CAD, a symbol library is used like these templates. A figure can be drawn once in great detail, stored in the library, called into the current drawing, and scaled to fit the rest of the drawing.
- Accuracy. Some CAD systems allow the drawing to be accurate to a tiny fraction of an inch. The computer can compute perfect ellipses, draw an exact tangent or draw a line at an angle which is precise to a fraction of a second.
- Less tedious. Some actions such as lettering and hatching are time-consuming and boring. With a computer lettering is as easy as typing and hatching can be done with a keystroke.
- Less manual skill. There are many potentially good drafters (and engineers and architects) who were discouraged from entering the profession because of their inability to draw a uniformly wide line or properly slanted letters.

THE SCOPE OF THIS REPORT

In this report we review several products which are available to secondary schools to teach Computer Aided Drafting. To gather the software packages for our reviews, we reviewed CAD periodicals, computer in education periodicals, advertisements, and recommendations of teachers. A product was considered for review if it was primarily for doing CAD or for teaching about it, if it ran on a system using either IBM DOS or Microsoft DOS (that is, if it was IBM compatible), and if the publisher of the software considered the package appropriate for secondary students.

After gathering the appropriate software, we searched for teachers who were currently teaching CAD to review the products from an educational perspective. We were surprised to learn how few teachers in the Northwest are currently teaching with CAD systems. Of these teachers few felt comfortable with the system they were using and fewer felt that they were qualified to evaluate other systems.

In addition to the shortage of teachers who were available to review the software, there was a problem with finding school settings with the appropriate equipment. While some of the packages operate on standard IBM compatible computers, others require such additions as enhanced graphics adapter cards, math co-processor chips, special input tablets or mice, special plotters, etc. Since these peripheral devices do not follow a standard protocol, the CAD software must have a way of communicating with the particular brand of peripheral that the school is using. These difficulties led us to separate the project into two reports: this report which discusses software for IBM PC and compatible computers and a previous report which discusses software for Apple Macintosh and Apple II computers.

WHAT FEATURES ARE IMPORTANT

In preparing to review the software for this report, teachers were asked what made a CAD system good in a secondary school setting. They agreed that the primary considerations were:

1. Cost of both the software and the hardware which hosts it
2. Ease of use
3. Ease of setup
4. The availability of coordinated curriculum materials

Several of the teachers stated that cost and ease of use were overwhelmingly important. If a system was rated high in those

features, they could adapt their teaching to make up for any missing features in a CAD program. They agreed that a system which would be considered inadequate in a work setting could be acceptable in a secondary school drafting class.

In addition to the above criteria, there were several features which were considered important in CAD software:

Dimensioning--A program which does dimensioning will put the measurements of a drawing element (or object) on the drawing automatically. A program which does this well will draw witness lines (or extension lines), measure both linear dimensions and angular dimensions, calculate the areas of enclosed objects, and allow the student to decide on the placement, size and style of the numbers.

Display--The computer screen should have some basic information in front of the student. There should be an indication of the cursor's coordinates, a menu of choices available to the student, and a reasonably good drawing of the object which the student is completing. There should be different ways to view the drawing including the ability to magnify a portion (zoom in) and shrink the drawing to see more of it (zoom out). The student should be able to draw an object which does not fit entirely on the screen and to pan across different parts of it.

Creating objects--The essence of any CAD program is, of course, how well and easily it allows the student to draw diagrams.

Lines--There should be options to draw lines by connecting two points, drawing freehand, restricting the line to a particular angle, to creating a line parallel or perpendicular to another, and to creating a tangent to a circle or arc.

Circles--A student should be able to create a circle by specifying the center and radius or diameter, or by specifying three points on the circumference.

Ellipses--A good program will allow the creation of an ellipse by specifying the major and minor radii.

Arcs--The student should be able to construct both quarter and full arcs.

Spline curves or Bezier curves--These are curves which follow a series of separate points and would have been made using a french curve in manual drafting.

Hatching--The student should be able to hatch an area in a specified pattern.

Layers--In professional drafting, drawings are often constructed in layers which are like plastic overlays to the drawing. In architectural drafting, for example, the floor plan

might be one layer, the electrical plan second, the plumbing a third, etc. A CAD system should allow the student to use several different layers.

Lettering--The student should be able to place lettering at any location and at any angle on the drawing. The size of the letters should be optional.

Grouping of objects--A group is an important entity in CAD systems. A collection of lines, curves, etc. may be a distinct unit or part in the total drawing. If this collection is grouped, it can then be moved, copied or otherwise modified as a unit.

Modifying drawings--Modifications to a diagram are necessary even during the completion of the drawing. A part which is drawn correctly but in the wrong place can be simply moved, rather than redrawn as in manual drafting. In cases such as creating gear teeth, the same part may be copied several times then moved or rotated into position. The most important modifications which should be allowed are:

Change scale

Move objects, groups, or text

Copy objects, groups, or text

Rotate objects, groups, or text

Snaps--Snaps allow the students to be more accurate in their drawings. With the snap feature on, when the student picks a location on the screen with the pointer, only certain points are possible. Most programs allow the student to define a grid and only points on the grid can be selected. For example, if the drawing will require line lengths in even quarters of an inch, the student would set a grid with quarter-inch increments. The program should have the option of turning the snap feature off for drawing parts which have dimensions not along the grid. Some programs also have a snap feature, "snap to objects," which positions the cursor on the line or curve nearest to the current location.

Output--A diagram from a CAD program is not useful while it is on the screen. There are a number of ways to produce the diagram in a useful form; among them are:

Plotter--A CAD program should allow the student to have a diagram printed using a plotter. There is no other standard output device in professional drafting. Plotters range in size (A through E) and the number of pens (and, therefore, colors) used. The more plotters which the program supports the better.

Laser Printer--While laser printers produce very good drawings, they tend to limit the size of the drawing to

standard letter or legal sizes and to black-on-white diagrams. Because of these limitations, the students will not likely be using a laser printer in a professional drafting environment.

Dot matrix printer--This output is the least desirable and should be considered only if the cost of a plotter is completely unmanageable. Dot matrix output usually reflects the screen image with jagged lines instead of straight lines, circles and arcs with curves which are not round and text which is unreadable.

Export as a text file--An ideal CAD program will save the drawing in a form which can be read by other programs along the chain of CAD to CAM (Computer Aided Manufacturing). The programs include 3D modeling, finite element analysis and finally the tool path settings for such manufacturing devices as numerical control milling machines. There are standards for how a diagram is translated from one program to the next. Of these, the Initial Graphics Exchange Standard (IGES) and the Drawing Interchange File (DXF) are the most prevalent.

Input--A CAD program should allow the student to create a diagram using whichever input device is most appropriate for the job. More realistically, however, a secondary school is not likely to have more than one type of input device other than the computer keyboard. In fact, many teachers attempt to teach CAD using only keyboard input.

Graphics tablet--The software should allow input from a graphics (or digitizing) tablet. This is the standard form of input in the profession. Unfortunately, because the tablets are expensive and fragile, few schools have them. There is no standard for how the tablets interact with the computer so a CAD program must have drivers for a variety of tablets.

Mouse--Since using a mouse is not yet an important feature in most software for IBM compatible microcomputers, few schools have them connected. Like the graphics tablet, the mouse which is used must be recognized by the software which is running.

Keyboard--Even if a tablet or mouse is being used, the program should allow the student to enter data through the keyboard. If, for example, a straight line between two points is called for, the best way to describe that line is through the coordinates of the two points. Virtually all text is entered through the keyboard regardless of the primary drawing tool.

Modeling--Some software will allow the student to take a two-dimensional drawing and create a three-dimensional model from it. Since modeling is rarely taught in secondary schools, this feature was not considered important by the drafting teachers.

Name: AutoCAD

Publisher: AutoDesk, Inc.
2320 Marinship Way
Sausalito, CA 94965
(415) 332-2344

Price: $2,850.00. Educational discounts available through your area AutoDesk representative. Call 800/445-5415 for the representative in your area.

AutoCAD is most prevalent in the professional microcomputer CAD systems. Since it was first copyrighted in 1982, this program has been continually improved and augmented to its current version which has most of a microcomputer's features. It is considered the standard among microcomputer systems because of its prevalence. Program enhancements are sold separately. In this review, all of the enhancements (ADE-1, ADE-2 and ADE-3) were included with the program. The use of the enhancements is transparent, that is, the student doesn't know that a particular function is there because of the program or the enhancement. Some features considered essential (e.g., dimensioning) are part of an enhancement package.

Because of the wide variety of input and output devices with which AutoCAD can work, installation and setup is relatively easy. It requires a hard disk and at least 540K of RAM memory. If you have more memory the program will use it automatically. The system will allow you to use two monitors, but students will probably find that one monitor is sufficient. Input can be made with a mouse, a graphics tablet or even the keyboard.

AutoCAD does well at drawing most objects. By setting the snap mode to "snap to objects," the student can draw perpendicular lines, align arcs to lines, intersect lines at their midpoints, etc. A powerful parallel command can be used to draw lines parallel to every line which makes up a complex object, creating a double line around it.

The reviewers expressed some difficulty in getting around in the program. Although each item can be selected through a branched set of on-screen menus, selection this way is tedious. A more common way of implementing commands is by typing the command name directly from the keyboard. This method is faster but requires remembering the exact name and removing one's hands from the mouse or tablet and going to the keyboard. While this seems a minor problem, in complex drawings the process becomes annoying.

The program is powerful in its native abilities and in its ability to add features. It contains a programming language (a language LISP version) which can be used to add commands to the system. This feature would probably be too difficult for most students, however.

Name: CADKey 1.4E
CADKey 3.0

Publisher: Micro Control Systems
27 Hartford Turnpike
Vernon, CN 06066
(203) 647-0220

Price: CADKey 1.4E - $495.00. CADKey 3.0 - $3,195.00. Educators may apply for a grant which, if approved, would provide a site license for the use of CADKey 1.4E at no cost. CADKey 3.0 is available to educators at $495.00. per work station.

CADKey is a two- and three-dimensional professional drafting system. In its full version (3.0) it contains virtually all of the construction tools available on any CAD system and adds such unusual elements as an on-line calculator, a programming language, and complete interaction between the two-dimensional and three-dimensional views of an object. There is also an educational version (1.4E) which uses the same menus as the full version but has some features missing. The educational version does not have an on-line calculator, a programming language, or macros, but has most of the construction tools of the full version.

Setup is easy except that in the 3.0 version a device must be installed on the computer which is running the program to prevent unauthorized copying of the program. The reviewers considered this method of copy protection to be inconvenient.

The strongest feature of the program from an educational perspective is the attention which has been paid to training in the use of the system. The manual contains a tutorial, there is a separate training manual, and there is a complete textbook which is available from an independent publisher. While there is no on-line help, the package includes reference cards and the manual is well-indexed. A set of on-line tutorials, called CAD Expert, is available for the system for an additional $395.00. The screen which is in front of the student includes a line which tells the recent history of commands which got the student to that point. If a student is having trouble, the teacher may get some idea of what occurred and how to fix it.

There is a comprehensive array of tools for creating objects. For each type of entity (e.g., lines, arcs, rectangles, etc.) there is a complete set of options which will make the drawing easier or more precise. For example, if a student chooses to create an arc, he or she may then choose from seven different ways of specifying that arc. Similarly, there are six ways to specify a circle, and ten ways of specifying a line. The price to pay for this comprehensive selection is that the student must make a number of choices even to make simple drawings. The

reviewers reported that some students get frustrated that some tasks seem difficult because they need to do so many things to make them happen. Because they were looking in the wrong menu for the package, some of the teachers who reviewed it reported that an action was not possible when, in fact, it was. In the educational version (1.4E) there is no tool for creating either spine curves or Bezier curves. This is, perhaps, the greatest problem with using the less powerful program.

Menu selections are made using the microcomputer's function keys, with the definition of each key changing with each selection. For example, to draw a line the student would type **F1** to tell the program to create an object; the menu would then change to list types of objects which can be created; the student would type **F1** again to select line creation; then **F1** again to indicate that the line will be created by specifying end points. While this method reduces the need to memorize command codes, it is less efficient for an experienced student who has created a particular type of line many times and would, therefore, have memorized a command code. Some actions which are repeated often (e.g., deleting an object) may be selected using the "immediate mode," a key combination which performs the action without using the menus. The reviewers praised this feature.

The three-dimensional section of both packages is very good for the difficult job of teaching how to create views of a part. In either version the student may request any of eight views of a part (top, bottom, back, front, left, right, isometric, axonometric) and may specify a unique view by stating the angles of the X,Y and Z axes.

The programming language and macros in the full version of the program were considered too difficult to use in secondary education. The reviewers stated that very few students would have the programming skills needed to master the language.

Name: CADLab

Publisher: Cascade Graphics Systems
16842 Von Karman Ave.
Irvine, CA 92714

Price: $1,990.00. An education discount of six packages for the price of five is available to schools.

This program seems to be designed for first-time CAD users. The manual takes the user from a definition of Computer Aided Drafting to the actual use of the program. While there is no tutorial, the manual is easy to use and understand. Most of the features which a professional CAD system uses are present. The system includes a wide variety of ANSI hatching patterns, a very good symbol library, and a complete set of options for forming, editing and manipulating groups of objects.

The system allows the use of low cost input devices such as the keyboard or joysticks as well as the usual graphics tablets and pointing devices. The program is only moderately easy to set up and use, however. A teacher who is not familiar with DOS would be unable to set up the system alone. While there is an installation program which performs most of the tasks, some must be completed in DOS and the manual is of little help.

The program would work best when used with a computer which has two monitors, one for the drawing and one for the menus. In a typical school setup with only one monitor, the student must constantly switch between reading the menus and seeing his or her work. It is quite common for the program to prompt the student for information, but that prompt cannot be seen because the student is looking at the drawing. A major drawback of the system is none of the information concerning the location of the cursor or the status of such attributes as line width, text height, etc. appear on the screen while the student is drawing. It is very difficult to create drawings without this information.

In a departure from the procedures in many CAD programs, in this package the student selects all of the actions by typing a two-number code on the keyboard. The mouse or graphics tablet is used only in the actual drawing process. Since codes are numeric, there is no mnemonic help in remembering the correct code (e.g., LI for line drawing). The codes are shown next to the menu item if the menu screen is showing.

Drawings are completed after the data which is required has been input. Since there is no dynamic depiction of an object as it is being created, the program is somewhat more difficult to use but faster than many.

Name: CADVance

Publisher: IsiCAD
200 Hacienda Ave.
Campbell, CA 95008
(714) 533-8910

Price: $2,795. A Curriculum Development Program which includes 3 complete software packages, 2 protection devices and a dxf transfer is available for $995.00 to accredited schools.

CADVance is a full-featured drafting system which is the choice of many professionals because of its ease of use and speed. Like other programs in its price range, CADVance has a complete set of two-dimensional drafting tools, a programming language, a database, and the ability to create macros and symbol libraries. The basic program does not include three-dimensional modeling, though additional programs are available to do this and IGES file transfers.

The program is relatively difficult to install. The installation program does not automatically set up the necessary directories or batch files to get you started. There is a program which will prompt you for information concerning your devices for input and output and will copy files to make those devices work with the program. There is a device which must be attached to the computer for the software to work. The reviewers found this addition to be inconvenient.

Once installed the program is easy to understand and use. Menu selections may be made using the mouse or the first letter of the menu item. When an item is selected, the program gives the student a clear message concerning what he or she should do next. For example, if a student selects the command **RECT** to draw a rectangle, the program will prompt "Corner 1..." and wait for the student to indicate where the first corner should be. The student will then be asked for corner 2.

The manual is particularly easy to use. Each section has clear examples, screen drawings, and a discussion of the purpose of each command. There is a tutorial section designed primarily to give an overview of the program. A quick reference guide gives the student a map through the menu choices. A separate technical reference manual provides instruction on the advanced features of the program.

In addition to the usual range of drawing tools, CADVance has some tools which are particularly well adapted to architectural drawing. The command **2LIN** draws parallel lines for making drawings of walls. The command **OPEN** breaks a single or parallel line then inserts a symbol such as a door into it.

As with other powerful programs, some of the power of CADVance may be lost in a secondary school environment. The use of the programming language and the database features would require much more training than is typically the goal in introductory CAD courses.

Name: Generic CADD 3.0

Publisher: Generic Software
8763 148th St. NE
Redmond, WA 98052

Price: $99.95 for basic system plus $49.95 for each of three extensions.

This CAD system is designed both for professional drafting and learning about CAD. Its design is modular, with the basic package containing most of the tools needed for teaching about CAD and optional extra modules to do more complex operations.

The software is easy to set up, with most of the installation done through a program which takes charge of the process. The range of possible devices to use for inputting and outputting is adequate for most systems. The keyboard can be used for all of the functions if you have a severe hardware shortage. Printing a drawing on a dot matrix or laser printer requires an optional module, however. A second optional module is required if you plan to transfer the file to another program through the IGES format.

Once installed the system is very easy to use. Any command can be selected from a series of branched menus or requested directly through a two-letter code. Most of the codes tend to be reasonably easy to remember (a straight line is **LI** and a circle drawn with two points, the center and a point on the circumference, is **C2**). Students who used the system tended to begin using the two-letter method of commands almost immediately. The screen display is informative, with coordinates, menu choices, and a prompt line.

The manual is very easy to read and use. It includes a brief tutorial, but not enough to teach about CAD to a class. A drawback of the manual comes from the program's modularity. Finding an item in the index requires looking in a separate index for each module which has been added. There is no on-line help.

Generic CAD has most of the functions which would be needed in teaching about CAD. Two critical features, auto-dimensioning and cross hatching, are missing from the main program but are available as options. Most objects can be drawn quite easily with the program using the cursor or by typing values directly from the keyboard. The system accepts absolute, relative or polar coordinates. The only important drawing function which is missing is the ability to create a Bezier curve. The ability to snap to geometrically determined points (e.g., midpoint of a line, perpendicular to a line, etc.) and the ability to construct fillets and chamfers are only available as an optional extra.

Name: Junior Drafter 1.2

Publisher: Learning Odyssey
841 Turquoise Street
Suite E
San Diego, CA 92109

Price: $1,995.00. Education price is $995.00 and further discounts available for quantity purchase.

Junior Drafter is an unusual product among those which were reviewed for this report. This package was designed to teach about CAD rather than primarily as a professional tool. The emphasis of the teaching is on using the most prevalent mainframe CAD system, IBM's CADAM. The Junior Drafter software emulates the CADAM program, but leaves out some of the tools which are available on that larger system. Student and teachers who are experienced on other microcomputer CAD systems may find the terms used in Junior Drafter unfamiliar.

Setting up the system is easy if you have the hardware expected by the program. The range of possible input and output devices is very limited and uncommon in a system which has not been purchased just for this program. Only a three-button mouse (the most common mouse for a microcomputer is a two-button model) can be used to input data. Only a Hewlett Packard plotter or dot matrix printer may be used to produce a hard copy. If you have this equipment, then the installation program is automatic, requiring no understanding of the DOS to get everything running.

The best feature of the system is, of course, its appropriateness for the classroom. The manual provides approximately 60 hours of instruction and teaches about CAD concepts as it describes how to use a particular function. In each description, there is a picture of how the screen should look before and after the function is used, and in many cases there are pictures of what intermediate screens will look like. There is a separate Computer Assisted Instructional tutorial which is designed to teach a student about drafting, CAD, Junior Drafter and CADAM. The tutorial is self-paced, a feature that should be valuable in a classroom without enough workstations for all of the students. In each lesson the program demonstrates the function or concept, guides the student through the function, then allows the student to practice the function. There is a management section which allows the teacher to check on the progress of the students using the system.

The screen which shows the student's drawing is well-designed and supports color. It displays important information such as the cursor location, the current drawing scale, the memory remaining, and the function which has been selected. One area is devoted to the options

available to the student at the current level of the program, and the most common choice is the default.

If the Junior Drafter system is evaluated simply as a CAD tool it does not do well. It is more awkward to use than the best of the systems. Some tools which might be considered essential in teaching drafting are missing from this package. Spline and Bezier curves cannot be drawn, there is no hatching available, and all elements of a drawing are on a single layer. Drawings are entirely two-dimensional, although there is a good feature for creating orthogonal views. The system is relatively slow.

The close relationship of this program to the mainframe system, CADAM, is either a strong positive or a moderate negative. The terminology for the system and the way of indicating actions to take are very different from most CAD programs. This difference will put the student in a good position to begin working on the more powerful CADAM software, but a bit confused if he or she goes to work for a company which uses a microcomputer-based CAD system.

Name: VersaCAD DESIGN Version 5.2

Publisher: Versacad Corporation
A Company of Prime Computer, Inc.
2124 Main Street
Huntington Beach, CA 92648
Phone: 714/960-7720

Price: $2,995.00. Educational discounts are available through your regional Versacad representative.

VersaCAD is one of the major microcomputer CAD systems available on a microcomputer. It consists of three modules which interact: a two-dimensional drawing system; a three-dimensional drawing system and a bill of materials system which creates a database of parts used in a drawing. VersaCAD is intended to be used as a professional system. Its use in education is to give students experience on the type of system which they are likely to encounter in the workplace. The system is particularly suited to architectural drafting with its excellent selection of line styles and symbols, but is also excellent for other types of drafting.

While very complex (the program comes on 18 disks), VersaCAD is relatively easy to install. There is an installation program which asks the user questions about the microcomputer's memory, graphics display, input device and output options then takes over the installation. The user needs only to keep feeding the correct floppy disk when asked. The options for the type of input and output devices is huge, covering virtually every combination (including laser printers). A potential drawback is that the program will not operate without a math co-processor, an extra chip for your computer costing $100-$350 depending on the type and speed of your computer. As with most CAD systems, a hard disk is a must. This program takes approximately 6 megabytes of space on a disk.

Once installed, VersaCAD is relatively easy to use. The computer screen is divided into sections. A menu area contains either the main menu or a submenu specific to the function the student is performing. Choices can be made by pointing to the item and selecting it with the input device or by typing the first letter of the menu item. (In practice, most students eventually use the typing method almost exclusively since it is faster and doesn't require them to leave the drawing area.) The menus are grouped logically and are comprehensive.

The screen also contains data on the current status of the program and the drawing. Cursor coordinates are always on-screen and the student may decide whether the coordinates are expressed as X-Y position, relative positions, or polar coordinates. Other information in

the status area includes telling the student whether particular functions (such as the "snap to objects") are active.

Strong advantages of the system include its speed, and its comprehensive set of options. The program is also precise. Linear dimensions can be shown to 16 decimal places. Students have access to a number of tools, including the ability to confine the slope of a line which they draw to an exact angle; the ability to construct fillets between lines, circles and arcs; trim lines in several ways; draw double lines with a variety of end caps; construct tangents to circles and arcs; and automatically create isometric drawings.

The manuals are well-organized and include a short tutorial for each of the three main segments of the program. An audio tour of the system is included on a cassette tape, and a keyboard overlay describes the action of each of the function keys. Context sensitive help is always available on-line.

The greatest weakness of the program which was cited by the reviewers was the overwhelming set of options which are available. Students sometimes get confused by the complex range of tools which are available when they are looking for the right tool for a simple drawing.

The system includes a programming language which allows a user to perform calculations, write programs, and customize menus. This feature was not considered particularly useful by the reviewers in that the students would have to understand programming concepts before attempting to use it. Similarly, constructing macros (series of pre-recorded steps), customizing menus, and adding additional on-line help are possible but were considered too difficult for most students or teachers to attempt.

A Comparison of Features of CAD Software

Software	ArtecCAD	CADKey 1.42	CADKey 3.0	CADLab	CADVance	Generic	Jr. Drafter	VersaCAD
Version number	[illegible]	1.42	3.0	6.01	1.30	3.0	1.2	5.2
Minimum memory	512	512	640	512	640	384	384	640
Retail Price	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Scaling	✔	✔	✔	✔	✔	✔	✔	✔
Coordinates on screen	✔	✔	✔	○	✔	✔	✔	✔
Relative coordinates	✔	✔	✔	✔	✔	✔	✔	✔
Polar Coordinates	✔	✔	✔	✔	✔	✔	✔	✔
Zoom In	✔	✔	✔	✔	✔	✔	✔	✔
Zoom Out	✔	✔	✔	✔	✔	✔	✔	✔
Linear Dimensioning	✔	✔	✔	✔	✔	ⓘ	✔	✔
Angular Dimensioning	✔	✔	✔	✔	✔	ⓘ	✔	✔
Area Calculation	✔	○	✔	○	✔	✔	○	✔
Circles by Radius	✔	✔	✔	✔	✔	✔	✔	✔
Circles by 3 point	✔	✔	✔	✔	✔	✔	✔	✔
Arcs by Radius	✔	✔	✔	✔	✔	✔	✔	
Arcs by 3 point	✔	✔	✔	✔	✔	✔	✔	✔
Bezier or spline curves	✔	○	✔	✔	✔	✔	○	✔
Hatching	✔	✔	✔	✔	✔	ⓘ	○	✔
Transfer to IGES	✔	ⓘ	ⓘ	○	ⓘ	ⓘ	○	✔
Transfer to DXF	✔	○	✔	○	ⓘ	ⓘ	○	✔
Layers (Number)	—	256	256	256	255	256	1	250
Snap to Grid	✔	✔	✔	✔	✔	✔	✔	✔
Snap to Objects	✔	✔	✔	○	✔	✔	✔	✔
Trim lines	✔	✔	✔	✔	✔	ⓘ	○	✔
Fillets	✔	✔	✔	✔	✔	○	○	✔
Group by selecting	✔	✔	✔	✔	✔	✔	✔	✔
Group by fencing	✔	✔	✔	✔	✔	✔	✔	✔
Draw lines by coordinates	✔	✔	✔	✔	✔	✔	✔	✔
Draw angles/arcs by coords	✔	✔	✔	✔	✔	✔	✔	✔
Move objects	✔	✔	✔	✔	✔	✔	✔	✔
Copy objects	✔	✔	✔	✔	✔	✔	✔	✔
Rotate objects	✔	✔	✔	✔	✔	✔	✔	✔

ⓘ Optional program available

A Comparison of Features of CAD Software (cont.)

Software	AutoCAD	CADKey 1.4E	CADKey 3.0	CADLab	CADVance	Generic	Jr. Drafter	VersaCAD
Move groups	✔	✔	✔	✔	✔	✔	✔	✔
Copy groups	✔	✔	✔	✔	✔	✔	✔	✔
Rotate groups	✔	✔	✔	✔	✔	✔	✔	✔
Rotate text	✔	✔	✔	✔	✔	✔	✔	✔
Plotting	✔	✔	✔	✔	✔	✔	✔	✔
Laser Printer	O	✔	✔	O	O	O	O	✔
Dot Matrix Printer	✔	✔	✔	✔	✔	①	✔	✔
Draw with keyboard	✔	✔	✔	✔	O	✔	O	✔
Draw with mouse	✔	✔	✔	✔	✔	①	✔	✔
Draw with tablet/pad	✔	✔	✔	✔	✔	✔	✔	✔
3D	O	✔	✔	O	O	O	O	✔
Symbol Library	✔	✔	✔	✔	✔	①	✔	✔
Isometric drawing	✔	✔	✔	O	✔	O	✔	✔
Tutorial	O	✔	✔	O	✔	✔	✔	✔
Curriculum materials	O	①	①	O	O	O	✔	O

① Optional program available

RECOMMENDATIONS

If a professional in one of the drafting fields uses a microcomputer-based CAD system, that system probably runs on an IBM PC or a compatible. If your goal is to prepare a student for an entry level job using CAD, then you too should be using PC-DOS based software. The eight programs reviewed for this report differ primarily in how comprehensive they are, how flexible they are, how expensive they are, how easy to use they are, and how easy to integrate into a secondary school curriculum they are, and what equipment they will operate on. Which system you purchase depends on which of these criteria are more or less important in how you intend to teach about CAD.

If you already have the hardware you intend to use, then some of the software can be eliminated immediately. If you have a small amount of random access memory (RAM) in your computers, then you cannot consider one of the programs which require 512K or 640K of memory. In fact, if you do not have a math co-processor you cannot consider VersaCAD at all. While upgrading memory or adding a co-processor is not prohibitive, the cost for several machines would make looking for a similar software package which will operate with what you already have attractive. Generic CAD is a good option since it has most of the features of the big systems and will fit on a computer with 384K of memory.

If you have the input and output device you will be using, then you should make sure that the system you choose will work with those devices. This report does not include a list of what software is compatible with what devices, since these lists change quickly. If you are interested in a piece of software, call the publisher or your local dealer, describe the equipment you will be using, and ask if their product will run on your equipment. If you are using a local dealer, it usually makes sense to purchase the software installed on your system, making the matching of hardware and software the dealer's responsibility.

Since you will probably not be teaching CAD exclusively, and will probably not even have a class totally devoted to CAD, look for a package which has a tutorial at least and a self-paced curriculum at best. Three of the packages, CADKey 1.4E, CADKey 3.0, and Jr. Drafter, have optional computer-based tutorials which allow the student to discover the system at his or her own pace. In fact one of these packages, Jr. Drafter, was written exclusively as a system to teach about CAD. Of the other packages reviewed, VersaCAD and CADVance have good tutorials as part of their manuals.

If you think your students might resist CAD if it begins to be too hard, look at one of the programs which the reviewers thought easy to use. Of the full professional systems, VersaCAD and CADVance were

thought to be easiest by the reviewers. Generic CAD was both easy to use and inexpensive.

If you want your students to be prepared for a job in the industry immediately after graduation, then they should learn on AutoCAD. It's not that all of the industry is using that program, but those who aren't recognize that if a student knows AutoCAD, he or she can probably learn the system that they are using relatively quickly. Alternately, if a large employer in you area is using mainframe-based CAD, then they are probably using IBM's CADAM and you might consider teaching with Jr. Drafter which emulates that program.

Overall, the best combination of price, features and curriculum materials is CADKey 1.4E. If you can live without a tool for constructing spline curves, then this program is a very good value. A second good choice might be Generic CAD with the optional dimensioning package and Drafting Enhancements I and II.

Finally, if your school already has a lab with Apple IIes and will not even consider buying new equipment for you to teach CAD, then review our companion report on Apple based CAD systems.